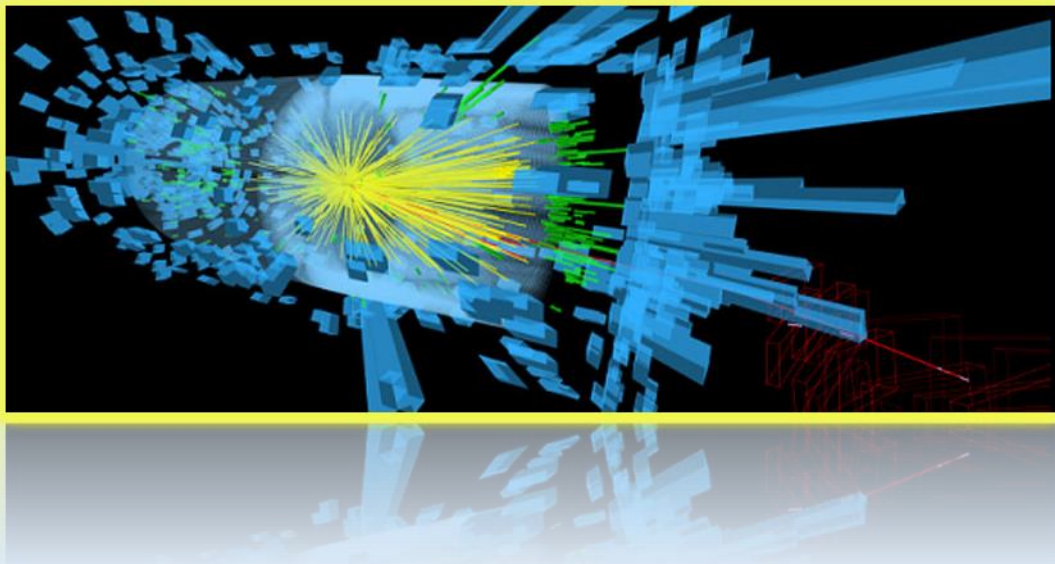


**B3-VI**

**Department of**

**High Energy Physics**

**(DHEP)**





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### Department of High Energy Physics

1. Name of the Department : Department of High Energy Physics (DHEP)
2. Year of establishment : 1945  
TIFR was divided into Research Groups in the period 1945 – 1997.  
The present Departments were formed on December 12, 1997.
3. Is the Department part of a School/Faculty of the university?  
The DHEP is a part of the Faculty of Natural Sciences.
4. Names of programmes offered (UG, PG, M.Phil., Ph.D., Integrated Masters; Integrated Ph.D., D.Sc., D.Litt., etc.)
  1. Ph.D.
  2. Integrated M.Sc.-Ph.D.
  3. M. PhilNo students are admitted purely for an M.Phil programme. However, sometimes students in the Ph.D. and Integrated Ph.D. programmes are permitted to leave with an M.Phil. degree provided they have successfully completed the Course Work and an M.Phil. dissertation.
5. Interdisciplinary programmes and departments involved  
The DHEP does not offer interdisciplinary programmes. However, there is a lot of research collaboration among the Departments, and the graduate school has Instructors drawn from all the five departments in Colaba.
6. Courses in collaboration with other universities, industries, foreign institutions, etc.  
DHEP has not participated in full courses outside TIFR. However, DHEP members have disseminated information through seminars, colloquia and discussion meeting held all over the country during the period 2011-15 (see Item 25).
7. Details of programmes discontinued, if any, with reasons  
No programmes have been discontinued since the inception of the TIFR University.

## 8. Examination System: Annual/Semester/Trimester/Choice Based Credit System

Students of the DHEP are offered a Course Work programme based on a mixture of compulsory Core Courses, choice-based Elective Courses and compulsory Project Work, on topics of their own choice. The detailed structure is given in the table below.

| Programme            | Duration (years) |            | Basic & Core Credits | Elective Credits | Project Credits | Total Credits |
|----------------------|------------------|------------|----------------------|------------------|-----------------|---------------|
|                      | Overall          | Coursework |                      |                  |                 |               |
| Ph.D.                | 5                | 1.5        | 28                   | 16               | 16              | 60            |
| Int. M.Sc.-Ph.D. (J) | 6                | 2.5        | 56                   | 28               | 16              | 100           |

N.B. Integrated M.Sc.-Ph.D. students who join after 4 years B.Sc. or equivalent are required to do only 36 Core Credits, i.e. 80 Credits in total.

The Academic Session is divided into two semesters: the Autumn Semester (August – November) and the Spring Semester (February – May). In addition, there may be courses run during the Winter break (December – January) and Summer break (May – July). Students who are not doing courses during the breaks are encouraged to participate in research projects with faculty members of their choice.

In each one-semester semester, students are evaluated by a Continuous Evaluation process consisting of

1. Assignments
2. Quizzes
3. Mid-semester Examination
4. End-semester Examination
5. Term paper (optional)

All students are required to do 16 Credits of Project work in their allotted Departments as a part of the Coursework. In Departmental Project I (8 Credits), they are required to study a topic of current interest outside of the textbooks and write a report on the state of art in that subject. In Departmental Project II (8 Credits), they are required to do a small original work, preferably (but not compulsorily) in the same area, or review some highly technical work which is known to be very difficult. Both these Projects are evaluated by a Committee of Faculty Members drawn from the different Departments.

## 9. Participation of the department in the courses offered by other departments

TIFR Physics Courses are divided into four levels, as per the table below.

| Level | Course Content                      | Participation                     |
|-------|-------------------------------------|-----------------------------------|
| I     | Basic Subjects                      | All 5 Physics Departments jointly |
| II    | Core Subjects                       | All 5 Physics Departments jointly |
| III   | Review Courses (Basic Elective)     | Relevant Department               |
| IV    | Topical Courses (Advanced Elective) | Relevant Department               |

Thus, DHEP faculty are involved in teaching the Level I and II courses in sharing with faculty from other Physics departments, and exclusively involved in teaching all Level III and IV courses in Particle Physics, as well as Experimental Techniques in High Energy Physics, Quantum Chromodynamics and Data Analysis for High Energy Experiments.

DHEP students are free to choose Electives in other Departments, even outside Physics, in consultation with the Subject Board of Physics.

## 10. Number of faculty positions:

|              | Faculty Designation with DAE Grade | Abbreviation (Item 11) | Number    |
|--------------|------------------------------------|------------------------|-----------|
| 1.           | Distinguished Professor (J)        | Dist. Professor (J)    | —         |
| 2.           | Senior Professor (I)               | Sr. Professor (I)      | 3         |
| 3.           | Professor (H)                      | —                      | 6         |
| 4.           | Associate Professor (G)            | Assoc. Professor (G)   | 2         |
| 5.           | Reader (F)                         | —                      | 2         |
| 6.           | Fellow (E)                         | —                      | —         |
| 7.           | Fellow (D)                         | —                      | 1         |
| <b>Total</b> |                                    |                        | <b>14</b> |

## 11. Faculty profile with name, qualification, designation, area of specialization, experience and research under guidance

|    | Name              | Designation       | Deg*  | Specialisation              | Exp <sup>†</sup> | Stu <sup>‡</sup> |
|----|-------------------|-------------------|-------|-----------------------------|------------------|------------------|
| 1. | Naba K. Mondal    | Sr. Professor (I) | Ph.D. | Indian Neutrino Observatory | 37               | 2                |
| 2. | Tariq Aziz        | Sr. Professor (I) | Ph.D. | Collider Physics, B-factory | 27               | 2                |
| 3. | Sunil K. Gupta    | Sr. Professor (I) | Ph.D. | γ ray Astronomy             | 27               | 1                |
| 4. | B.S. Acharya      | Professor (H)     | Ph.D. | γ and X-ray Astronomy       | 29               | 0                |
| 5. | C.S. Unnikrishnan | Professor(H)      | Ph.D. | Gravitation                 | 22               | 6                |
| 6. | Sudeshna          | Professor (H)     | Ph.D. | Collider Physics, INO       | 22               | 1                |

|     |                     |                      |       |                                       |    |   |
|-----|---------------------|----------------------|-------|---------------------------------------|----|---|
|     | Banerjee            |                      |       |                                       |    |   |
| 7.  | Kajari Mazumdar     | Professor (H)        | Ph.D. | Collider Physics                      | 23 | 3 |
| 8.  | Shashi R. Dugad     | Professor (H)        | Ph.D. | Collider physics, $\gamma$ ray Astro. | 22 | 1 |
| 9.  | Gobinda Majumder    | Professor (H)        | Ph.D. | Collider Physics, INO                 | 15 | 3 |
| 10. | Monoranjan Guchait  | Assoc. Professor (G) | Ph.D. | Collider Physics                      | 11 | 6 |
| 11. | Gagan B. Mohanty    | Assoc. Professor (G) | Ph.D. | Collider Physics, B-factories         | 7  | 7 |
| 12. | N. Krishnan         | Reader (F)           | Ph.D. | Gravitation                           | 25 | 0 |
| 13. | Varsha R. Chitnis   | Reader (F)           | Ph.D. | $\gamma$ and X-ray Astronomy          | 5  | 1 |
| 14. | Prabhata K. Mohanty | Fellow (D)           | Ph.D. | $\gamma$ ray Astronomy                | 1  | 0 |

\* Highest degree obtained

† Years of Experience as a regular Faculty Member (TIFR and elsewhere)

‡ Ph.D. students guided within the last 4 years (including those joined and those graduated)

12. List of senior Visiting Fellows, adjunct faculty, emeritus professors

There were none appointed during the period 2011 – 2015.

13. Percentage of classes taken by temporary faculty – programme-wise information  
DHEP does not employ temporary faculty.

14. Programme-wise Student Teacher Ratio

|    | Programme              | Students (S) | Faculty (F) | Ratio S/F   |
|----|------------------------|--------------|-------------|-------------|
| 1. | Ph.D.                  | 10           | 14          | 0.71        |
| 2. | Integrated M.Sc.-Ph.D. | 10           | 14          | 0.71        |
| 3. | M.Sc.                  | –            | –           | –           |
|    | <b>Total</b>           | <b>20</b>    | <b>14</b>   | <b>1.42</b> |

15. Number of academic support staff (technical) and administrative staff:

|              | Scientific & Technical Staff | Administrative & Auxiliary Staff | Total     |
|--------------|------------------------------|----------------------------------|-----------|
| DHEP         | 45                           | 4                                | 49        |
| PCM          | 2                            | 8                                | 10        |
| CRL          | 19                           | 4                                | 23        |
| <b>Total</b> | <b>66</b>                    | <b>16</b>                        | <b>82</b> |

## 16. Research thrust areas as recognized by major funding agencies

- Accelerator Physics, including L3, D0, CMS and Belle Collaborations
- Non-accelerator Physics, including INO, GRAPES, HEGRO and LIGO Collaborations

## 17. Number of faculty with ongoing projects from a) national b) international funding agencies and c) Total grants received. Give the names of the funding agencies, project title and grants received project-wise.

**National**

|    | <b>Funding Agency</b> | <b>Project Title</b>     | <b>Duration (years)</b> | <b>Tot. Grant (Rs. lakhs)</b> | <b>Faculty member</b> |
|----|-----------------------|--------------------------|-------------------------|-------------------------------|-----------------------|
| 1. | DST                   | WLCG Grid DST Component  | 5                       | 1465.50                       | Kajari Mazumdar       |
| 2. | DST                   | J. C. Bose Fellowship    | 6                       | 38.60                         | N.K.Mondal            |
| 3. | DST                   | Indo-Belgian DST Project | 3                       | 8.02                          | Kajari Mazumdar       |

**International : none**

## 18. Inter-institutional collaborative projects and associated grants received

None

## 19. Departmental projects funded by DST-FIST; UGC-SAP/CAS, DPE; DBT, ICSSR, AICTE, etc.; total grants received.

|    | <b>Funding Agency</b> | <b>Project Title</b>  | <b>Duration (years)</b> | <b>Tot. Grant (Rs. lakhs)</b> | <b>Faculty</b>  |
|----|-----------------------|---|-------------------------|-------------------------------|-----------------|
| 1. | DAE                   | Enhancement Of Regional WLCG Grid   | 7                       | 3679.96                       | Kajari Mazumdar |
| 2. | DAE                   | Development Of Site Infrastructure And Prototype For India Based Neutrino Observatory (INO) | 5                       | 3274.00                       | N.K.Mondal      |
| 3. | DAE                   | Study Of New Particles With The CMS Detector At The Large Hadron Collider                   | 3                       | 87.97                         | S. Banerjee     |

|     |     |   |   |      |                           |
|-----|-----|---|---|------|---------------------------|
| 4.  | DAE | XII Plan Project – DHEP (3 projects)                                | 5 | 1295 | All DHEP members          |
| 5.  | DAE | CMS M&O contribution  | 5 | 988  | All India CMS members     |
| 6.  | DAE | SiPM Readout  | 5 | 48   | S. Dugad                  |
| 7.  | DAE | CMS-2   | 5 | 491  | All CMS members from TIFR |
| 8.  | DAE | Fermilab D0   | 5 | 11   | S. Banerjee               |
| 9.  | DAE | SiPM Development  | 5 | 97   | S. Dugad                  |
| 10. | DAE | Study of rare decays and CP violation at the KEK B factory in Japan | 5 | 217  | G. Mohanty                |

20. Research facility / centre with
- state recognition :
  - national recognition :
  - international recognition :

At present, there are none such in the DHEP.

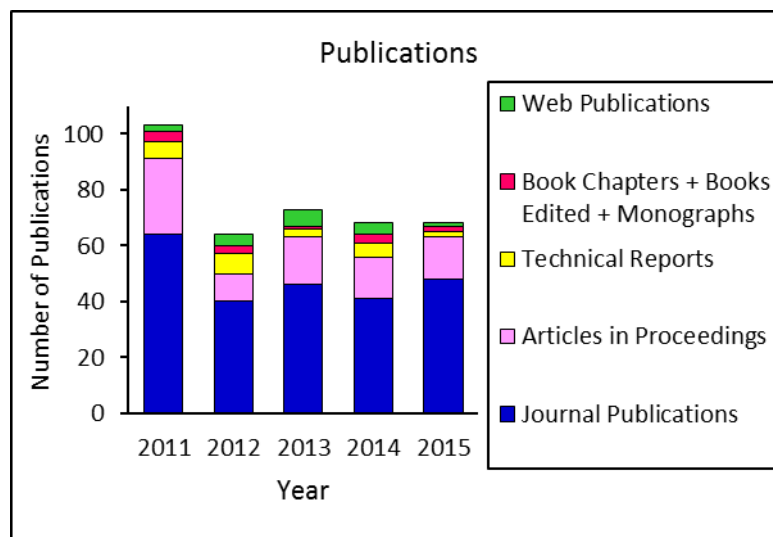
21. Special research laboratories sponsored by / created by industry or corporate bodies

At present, there are none such in the DHEP.

22. Publications:

| DHEP         | Journal Publications | Articles in Proceedings | Technical Reports | Web Publications | Book Chapters | Books Edited | Mono-graphs |
|--------------|----------------------|-------------------------|-------------------|------------------|---------------|--------------|-------------|
| 2010-11      | 64                   | 27                      | 6                 | 2                | 3             | 1            | —           |
| 2011-12      | 40                   | 10                      | 7                 | 4                | 2             | 1            | —           |
| 2012-13      | 46                   | 17                      | 3                 | 6                | —             | —            | 1           |
| 2013-14      | 41                   | 15                      | 5                 | 4                | 1             | —            | 2           |
| 2014-15      | 48                   | 15                      | 2                 | 1                | 1             | 1            | —           |
| <b>Total</b> | <b>239</b>           | <b>84</b>               | <b>23</b>         | <b>17</b>        | <b>2</b>      | <b>3</b>     | <b>3</b>    |





\* Books with ISBN with details of publishers : **None**

\* Citation Index –

Total number of citations: **5,29,350**

Number of citations per faculty: **37,811**

\* h-index :           Range           **2 – 129**

23. Details of patents and income generated

**DHEP has none in the period 2011-15.**

24. Areas of consultancy and income generated

**DHEP has none in the period 2011-15.**

25. Faculty selected nationally / internationally to visit other laboratories / institutions / industries in India and abroad

**National Visits :**

|    | <b>Faculty member</b> | <b>Place visited</b>   | <b>Date</b> |
|----|-----------------------|--|-------------|
| 1. | C.S. Unnikrishnan     | Discussion Meeting on Quantum Measurements, IISc. Bengaluru. | 10/2015     |

|     | Faculty member    | Place visited   | Date    |
|-----|-------------------|---|---------|
| 2.  | C.S. Unnikrishnan | International Conference on Matters of Gravity and the Universe, Centre for Theoretical Physics, Jamia Millia Islamia, New Delhi.             | 10/2015 |
| 3.  | C.S. Unnikrishnan | Current Trends in Atomic, Molecular and Optical Physics, University of Delhi.   | 03/2015 |
| 4.  | C.S. Unnikrishnan | 25th Meeting of the Indian Association for General Relativity and Gravitation (IAGRG), Raman Research Institute, Bengaluru.                   | 03/2015 |
| 5.  | G. Majumder       | National Symposium on Particles, Detectors and Instrumentation, IICHEP, Madurai.  | 03/2015 |
| 6.  | K. Mazumdar       | Two days workshop on Accelerating International Collaboration in Science Through Connective Computation, University of Chicago Centre, Delhi. | 03/2015 |
| 7.  | V.R. Chitnis      | National Symposium on Particles, Detectors and Instrumentation, IICHEP Transit Campus, Madurai.   | 03/2015 |
| 8.  | G. Majumder       | Simulation and Computational Techniques, LNMIIT, Jaipur.  | 01/2015 |
| 9.  | C.S. Unnikrishnan | XIX Congress of the CPFS, New Delhi.  | 12/2014 |
| 10. | K. Mazumdar       | DAE-BRNS symposium on High Energy Physics; IIT Guwahati.  | 12/2014 |
| 11. | M. Guchait        | DAE-BRNS symposium on High Energy Physics, IIT Guwahati.  | 12/2014 |
| 12. | S. Banerjee       | XXI DAE-BRNS High Energy Physics Symposium, Guwahati.   | 12/2014 |
| 13. | B.S. Acharya      | National Students' Space Challenge (NSSC-2014), IIT Kharagpur.  | 11/2014 |
| 14. | C.S. Unnikrishnan | International Workshop on Futuristic Navigational Sensors & Systems, Research Centre Imarat, DRDO, Hyderabad.                                 | 06/2014 |
| 15. | B.S. Acharya      | Workshop on Contemporary Trends in High Energy Physics and Experimentation (WCTHEPE-2014), Panjab University, Chandigarh.                     | 03/2014 |
| 16. | S.R. Dugad        | Workshop on Contemporary Trends in High Energy Physics and Experimentation, Panjab University.  | 03/2014 |
| 17. | V.R. Chitnis      | 32nd meeting of the Astronomical Society of India, IISER, Mohali.   | 03/2014 |
| 18. | C.S. Unnikrishnan | International Program on Quantum Information, Institute of Physics, Bhubaneswar.  | 02/2014 |
| 19. | C.S. Unnikrishnan | International Program on Quantum Information, Institute of Physics, Bhubaneswar.  | 02/2014 |

|     | Faculty member    | Place visited   | Date    |
|-----|-------------------|---|---------|
| 20. | C.S. Unnikrishnan | 9th Nalanda Dialogue, Nava Nalanda Mahavihara, Nalanda.   | 01/2014 |
| 21. | B.S. Acharya      | 8th Winter Workshop on Astroparticle Physics (WAPP), Bose Institute, Darjeeling.                                  | 12/2013 |
| 22. | C.S. Unnikrishnan | International Meet on Quantum Correlations and Logic, Language and Set Theory, IIT, Jodhpur.                      | 12/2013 |
| 23. | V.R. Chitnis      | 8th Winter Workshop on Astroparticle Physics (WAPP), Bose Institute, Darjeeling                                   | 12/2013 |
| 24. | B.S. Acharya      | National Symposium on VHE Gamma Ray Astronomy, BARC.  | 11/2013 |
| 25. | V.R. Chitnis      | National Symposium on VHE Gamma Ray Astronomy, BARC.  | 11/2013 |
| 26. | G.B. Mohanty      | Workshop on Status of Supersymmetry and Dark Matter (SUSY- DM), CHEP, Bengaluru.                                  | 10/2013 |
| 27. | C.S. Unnikrishnan | 9th Field Theoretic Aspects of Gravity (FTAG), IIT Gandhinagar.   | 09/2013 |
| 28. | C.S. Unnikrishnan | 39th COSPAR Scientific Assembly, Session Cold Atom Clocks in Space.   | 07/2013 |
| 29. | M. Guchait        | AD65, IISER, Kolkata.   | 03/2013 |
| 30. | G.B. Mohanty      | Conference on CP Violation in Elementary Particles and Composite Systems (PCPV 2013), Mahabaleshwar, Maharashtra. | 02/2013 |
| 31. | B.S. Acharya      | DAE-BRNS Workshop on Very High Energy Gamma-ray Astronomy, GOALS(BARC), Mt. Abu.                                  | 01/2013 |
| 32. | C.S. Unnikrishnan | 8th Dialog, Nalanda Dialog Forum, Nalanda Mahavihara.   | 01/2013 |
| 33. | G. Majumder       | XX DAE Symposium, Viswabharti, VisvaBharati, Santiniketan.  | 01/2013 |
| 34. | S. Banerjee       | XX DAE-BRNS Smposium, Shantiniketan.  | 01/2013 |
| 35. | K. Mazumdar       | Golden Jubilee celebration of Institute of Mathematical Sciences, Chennai.  | 12/2012 |
| 36. | M. Guchait        | From Strings to LHC III Meeting, Puri.  | 12/2012 |
| 37. | T. Aziz           | Hess Symposium, Kolkata.  | 09/2012 |
| 38. | B.S. Acharya      | Centenary Seminar 2012: Discovery of Cosmic Rays; Dept of Physics, Gauhati University, Guwahati.                  | 08/2012 |
| 39. | G. Majumder       | Higgs and New Physics at the Energy Frontier, Saha Institute of Nuclear Physics, Kolkata.                         | 08/2012 |
| 40. | G. Majumder       | Top-Higgs Meeting, Center for High Energy Physics HEP, IISc, Bengaluru.   | 08/2012 |
| 41. | G. Majumder       | National Meet, INSA, Delhi.   | 08/2012 |
| 42. | G.B. Mohanty      | Top-Higgs Meeting, CHEP, IISc, Bengaluru.   | 08/2012 |

|     | Faculty member    | Place visited  | Date    |
|-----|-------------------|--|---------|
| 43. | K. Mazumdar       | Symposium on "God Particle Demystified", B.P. Baria Science Institute, Navsari, Gujarat.   | 08/2012 |
| 44. | K. Mazumdar       | One-day National Meet on "India at the LHC", INSA, Delhi.  | 08/2012 |
| 45. | M. Guchait        | Top-Higgs Meeting, Centre for High Energy Physics, IISc, Bengaluru.  | 08/2012 |
| 46. | C.S. Unnikrishnan | ASTROD-5 Symposium, Raman Research Institute, Bengaluru.   | 07/2012 |
| 47. | G.B. Mohanty      | International Workshop on Grid and Cloud Computing (InGrid 2012), IIT Bombay.  | 04/2012 |
| 48. | C.S. Unnikrishnan | International Conference on Nature of Physical Reality: The Perennial Debate, IAS, Shimla.   | 03/2012 |
| 49. | C.S. Unnikrishnan | Indo-UK Seminar on Ultra-cold atoms and applications, NISER, Bhubaneswar.  | 03/2012 |
| 50. | G.B. Mohanty      | National conference on understanding the fundamental interactions, Department of Physics, Utkal University, Bhubaneswar.                               | 03/2012 |
| 51. | N. K. Mondal      | Advances in Astroparticle Physics and Cosmology 2012, Darjeeling, West Bengal.   | 03/2012 |
| 52. | T. Aziz           | Workshop on the Frontiers of Nuclear and Particle Physics, AMU, Aligarh, UP.   | 03/2012 |
| 53. | C.S. Unnikrishnan | International Workshop on Quantum Information, HRI Allahabad.  | 02/2012 |
| 54. | G.B. Mohanty      | Asian Forum for Accelerators and Detectors Workshop (AFAD-2012), VECC, Kolkata.  | 02/2012 |
| 55. | N. K. Mondal      | Seminar on History of Physics, Arambagh College, West Bengal, India.   | 01/2012 |
| 56. | B.S. Acharya      | Conference on Astro-particle physics and Astrophysics - "Exploring the Cosmos: 100 years of Cosmic ray Physics", University of North Bengal, Siliguri. | 12/2011 |
| 57. | B.S. Acharya      | 6th Workshop on Astro-Particle Physics (WAPP) Darjeeling.  | 12/2011 |
| 58. | N. K. Mondal      | Symposium on Amazing particles and Light: IISc, Bengaluru.   | 12/2011 |
| 59. | C.S. Unnikrishnan | EGO-IndIGO Indo- Italian meeting on Gravitational Waves, IUCAA.  | 11/2011 |
| 60. | K. Mazumdar       | Conference on Emerging Trends in Computing Technologies, Dr. Paul's Engineering College, Veluchery, TamilNadu.   | 09/2011 |
| 61. | N. K. Mondal      | Mini-workshop on theoretical aspects of Neutrino Physics, PRL, Ahmedabad.  | 09/2011 |
| 62. | B.S. Acharya      | Theme meeting on VHE Gamma Ray Astronomy, GOALS  | 03/2011 |

|     | Faculty member    | Place visited  | Date    |
|-----|-------------------|--|---------|
|     |                   | (BARC), Mt Abu.  |         |
| 63. | C.S. Unnikrishnan | National workshop on recent trends in theoretical physics, Cochin University of Science & Technology, Kochi                            | 03/2011 |
| 64. | G. Majumder       | Discussion meeting on Physics at early run of the LHC, Indian Association for the Cultivation of Science (IACS), Kolkata.              | 03/2011 |
| 65. | N. K. Mondal      | National Conference on Particle Physics & Cosmology, University of Bardhaman, Bardhaman.   | 03/2011 |
| 66. | C.S. Unnikrishnan | International conference on Quantum Information Processing and Applications, Allahabad.  | 02/2011 |
| 67. | C.S. Unnikrishnan | National conference on ancient and modern astronomy and cosmology, University of Madras, Chennai                                       | 02/2011 |
| 68. | C.S. Unnikrishnan | Workshop on Individuation and dentity, Nava Nalanda Mahavihara, Nalanda.   | 02/2011 |
| 69. | C.S. Unnikrishnan | UGC National seminar on Gravitation and Cosmology, North Bengal University, Siliguri.  | 02/2011 |
| 70. | C.S. Unnikrishnan | International Conference on 75 Years of Quantum Entanglement, Kolkata.   | 01/2011 |
| 71. | G. Majumder       | LHC discussion meeting, Viswa-Bharati, Santiniketan.   | 01/2011 |
| 72. | G. Majumder       | Exploring the cosmos: A National Conference on Relativistic Astrophysics and Astroparticle physics, North Bengal University, Siliguri. | 01/2011 |

#### International Visits :

|    | Faculty member | Place visited   | Date    |
|----|----------------|---|---------|
| 1. | B.S. Acharya   | 13 <sup>th</sup> Annual NNN International workshop on "Next Generation Nucleon Decay and Neutrino Detectors (NNN2012), Fermi National Accelerator Laboratory (FNAL), USA. | 10/2012 |
| 2. | B.S. Acharya   | Workshop on Detection of EAS at High altitudes, APC, France.  | 05/2014 |
| 3. | B.S. Acharya   | LUTH Observatory de Paris, Meudon, France.  | 06/2014 |
| 4. | B.S. Acharya   | Fermilab, USA.  | 08/2014 |
| 5. | B.S. Acharya   | Wisconsin IceCube Particle Astrophysics Centre (WIPAC) at the University of Wisconsin, Madison, USA.  | 02/2015 |
| 6. | T. Aziz        | KEK, Japan  | 11/2011 |
| 7. | S. Banerjee    | XXIst International Europhysics Conference on High  | 07/2011 |

|     |               |   |         |
|-----|---------------|---|---------|
|     |               | Energy Physics, Grenoble, France.   |         |
| 8.  | S. Banerjee   | 13 <sup>th</sup> Annual NNN International Workshop on “Next Generation Nucleon Decay and Neutrino Detectors (NNN2012), FNAL, USA.   | 10/2012 |
| 9.  | S. Banerjee   | European Physics Society Conference on High Energy Physics, Stockholm.  | 07/2013 |
| 10. | S. Banerjee   | 1 <sup>st</sup> Bangladesh-CERN School on Particle Physics at the High Energy Frontier, Dhaka, Bangladesh.  | 12/2014 |
| 11. | M. Guchait    | ICTP, Trieste, Italy.   | 09/2011 |
| 12. | M. Guchait    | 20 <sup>th</sup> International Conference on Supersymmetry and Fundamental interactions(SUSY12), Peking University Beijing, China.  | 08/2012 |
| 13. | M. Guchait    | 21 <sup>st</sup> International conference on Supersymmetry and Unification of Fundamental Interactions (SUSY 2013), International Center for Theoretical Physics, Trieste, Italy. | 08/2013 |
| 14. | G. Majumder   | EU-IndiaGrid2 meeting, Brussels, Belgium.   | 02/2012 |
| 15. | G. Majumder   | XVI International Workshop on Neutrino Telescopes, Venice, Italy.   | 03/2015 |
| 16. | K. Mazumdar   | International Conference on High Energy Physics (ICHEP12), Melbourne, Australia, (on behalf of CMS collaboration).  | 07/2012 |
| 17. | K. Mazumdar   | Hadron Collider Physics Symposium (HCP), Kyoto, Japan (On behalf of CMS and ATLAS collaborations).  | 11/2012 |
| 18. | K. Mazumdar   | 37 <sup>th</sup> international Conference on High Energy Physics (ICHEP), Valencia  | 06/2014 |
| 19. | G. B. Mohanty | KEK , Tsukuba, Japan  | 04/2012 |
| 20. | G. B. Mohanty | Flavor Physics and CP Violation (FPCP 2011), Maale Hachamisha, Israel.  | 05/2011 |
| 21. | G. B. Mohanty | 6 Belle Physics Advisory Committee Review Meeting, KEK, Japan.  | 02/2012 |
| 22. | G. B. Mohanty | 47 <sup>th</sup> Rencontres de Moriond Electroweak, La Thuile, Italy.   | 03/2012 |
| 23. | G. B. Mohanty | Flavor Factory Workshop (KEK-FF2013), KEK, Japan, March 2013.   | 03/2013 |
| 24. | G. B. Mohanty | 61 <sup>th</sup> Belle General Meeting, KEK, Japan.   | 03/2013 |
| 25. | G. B. Mohanty | Belle Analysis Meeting, KEK, Japan.   | 01/2013 |
| 26. | G. B. Mohanty | 62 <sup>nd</sup> Belle General Meeting, Virginia Tech, Blacksburg, Virginia, USA.   | 07/2013 |
| 27. | G. B. Mohanty | 15 <sup>th</sup> Open Meeting of the Belle II Collaboration, Virginia Tech, Blacksburg, Virginia, USA.  | 07/2013 |
| 28. | G. B. Mohanty | 6 <sup>th</sup> International Workshop on Charm Physics(CHARM2013), Manchester, UK,   | 08/2013 |

|     |                    |  |         |
|-----|--------------------|--|---------|
| 29. | G. B. Mohanty      | 8 <sup>th</sup> International Workshop on the Unitarity Triangle (CKM2014), Vienna, Austria.                           | 09/2014 |
| 30. | G. B. Mohanty      | 20 <sup>th</sup> Particles and Nuclei International Conference (PANIC 2014), Hamburg, Germany.                         | 08/2014 |
| 31. | G. B. Mohanty      | 5 <sup>th</sup> Workshop on Theory, Phenomenology and Experiments in Flavor Physics (Capri 2014), Capri Island, Italy. | 05/2014 |
| 32. | V.R. Chitnis       | CTA Collaboration Meeting, Amsterdam, Netherlands.   | 05/2012 |
| 33. | N. K. Mondal       | ASPERA 2011, Paris.  | 11/2011 |
| 34. | C. S. Unnikrishnan | The Indian Roadmap for Gravitational-Wave Astronomy: IndIGO - ACIGA meeting on LIGO-Australia.                         | 02/2011 |
| 35. | C. S. Unnikrishnan | Caltech, Pasadena, USA and LIGO Laboratory, Livingston, USA.   | 09/2012 |
| 36. | C. S. Unnikrishnan | University of Glasgow and University of Birmingham, UK.  | 02/2013 |
| 37. | C. S. Unnikrishnan | International workshop on anti-matter and gravity (WAG2013), Bern, Switzerland.  | 11/2013 |
| 38. | C. S. Unnikrishnan | Indo-UK Seminar on Astronomy with Global Gravitational wave networks, Cardiff University, UK.                          | 02/2013 |
| 39. | C. S. Unnikrishnan | Laboratoire de Physique des Lasers (LPL) at the University of Paris 13.  | 06/2013 |
| 40. | C. S. Unnikrishnan | Albert Einstein Institute (AEI), Leibniz University of Hannover.   | 09/2013 |
| 41. | C. S. Unnikrishnan | GEO600 gravitational wave detector, Hannover, Germany.   | 09/2013 |
| 42. | C. S. Unnikrishnan | Microscope Colloquium III, Palaiseau, Paris, France.   | 11/2015 |
| 43. | C. S. Unnikrishnan | 50 <sup>th</sup> Rencontres de Moriond (Gravitation, 100 years after GR), La Thuile, Italy.                            | 03/2015 |

## 26. Faculty serving in

**(a) National Committees :**

|    | Faculty Member | Name of the Committee   | Role in the Committee | Term of Service |
|----|----------------|---|-----------------------|-----------------|
| 1. | T. Aziz        | DAE-DST Task Force  | Member                | 2007 –          |
| 2. | S. Banerjee    | National Symposium on Particle, Detector and Instrumentation, IICHEP, Madurai, March 2012 | Co-convenor           | 2012            |
| 3. | S. Banerjee    | XXI DAE-BRNS High Energy Physics  | Member                | 2014            |

|     |              |   |                   |                 |
|-----|--------------|---|-------------------|-----------------|
|     |              | Symposium, IIT, Guwahati, Dec 2014  |                   |                 |
| 4.  | S. Banerjee  | National Symposium on Particle, Detector and Instrumentation, IICHEP, Madurai, March 2015 | Co-convenor       | 2015            |
| 5.  | M. Guchait   | NOC, "From Strings to LHC III, Dec 8-14,2012  | Member            | 2012            |
| 6.  | M. Guchait   | NOC, DAE HEP symposium, 2013  | Member            | 2013            |
| 7.  | M. Guchait   | Workshop in HEP, Dec 12-21,2013   | Convener          | 2013            |
| 8.  | M. Guchait   | Workshop in HEP, Dec 4-14,2015  | Co-convenor       | 2015            |
| 9.  | G. Majumder  | Workshop on High Energy Physics Phenomenology, Mahabaleswar, Jan 2012                     | Member            | 1 year          |
| 10. | G. Majumder  | IndGrid 2012 Workshop, IIT, Mumbai, April 2012  | Member            | 1 year          |
| 11. | G. Majumder  | Higgs and new physics at the energy frontier, SINP, Kolkata, Aug 2012                     | Member            | 4 months        |
| 12. | G. Majumder  | The second Asia-Europe-Pacific School of High-Energy Physics, Puri, India, Nov 2014       | Member            | 1 year          |
| 13. | G. Majumder  | XXI DAE-BRNS High Energy Physics Symposium, IIT, Guwahati, Dec 2014                       | Member            | 1 year          |
| 14. | G. Majumder  | National Symposium on Particle, Detector and Instrumentation, IICHEP, Madurai, March 2015 | Scientific Member | 1 year          |
| 15. | G. Majumder  | SERC School on experimental High Energy Physics, DST (2014-2019)                          | Member            | 5 years         |
| 16. | K. Mazumdar  | Specialist Group-9 for Budget proposals of DAE  | Member            | 2011 onwards    |
| 17. | K. Mazumdar  | DST-Programme Advisory Committee  | Member            | 3 years 2012-15 |
| 18. | K. Mazumdar  | International Workshop on Grid and Cloud Computing at IIT, BOMBAY, 2012                   | Member            | 1 year          |
| 19. | K. Mazumdar  | India-CMS collaboration   | Coordinator       | 2 + 2 years     |
| 20. | G.B. Mohanty | National advisory committee for the SERC school on experimental high energy physics       | Member            | 2011-2013       |
| 21. | N.K. Mondal  | INO Project Management Board  | Convener          | ongoing         |
| 22. | N.K. Mondal  | INO Project Management Board  | Convener          | ongoing         |

**(b) International Committees :**

None



**(c) Editorial Boards :**

|    | Faculty Member    | Name of the Journal | Impact Factor | Term of Service |
|----|-------------------|---------------------|---------------|-----------------|
| 1. | C.S. Unnikrishnan | Frontiers           | 1.2           | Invited         |

27. Faculty recharging strategies (UGC, ASC, Refresher / orientation programs, workshops, training programs and similar programs).

As all TIFR faculty members regularly participate in national and international research-oriented symposia, conferences, workshops and schools, often as the organizers or principal lecturers, they are always in touch with the state of the art in their areas of expertise. Therefore, no separate recharging/refresher programmes are needed, nor are any conducted. In fact, TIFR faculty are in great demand as lecturers in such programmes in other institutions, both inside and outside India.

28. Student projects

- percentage of students who have done in-house projects including inter- departmental projects

ALL (100%) TIFR students are required to do two Departmental Projects, viz. Departmental Project I and Departmental Project II (see Item 8 above).

- percentage of students doing projects in collaboration with other universities / industry / institute

Almost all TIFR faculty and laboratories have collaborations with scientists in India and abroad. Students of these faculty members and laboratories participate in these projects. Thus the percentage of students involved in such projects may be 95% or more.

29. Awards / recognitions received at the national and international level

**National Awards**

|    | Awardee        | Name of the Award/Honour                                   | Year |
|----|----------------|--|------|
| 1. | Tariq Aziz     | Fellow, Indian National Science Academy, New Delhi         | 2015 |
| 2. | G. Majumder    | Fellow, Indian Academy of Sciences, Bangalore              | 2014 |
| 3. | Naba K. Mondal | "Doctor of Science (Honoris Causa)", University of Burdwan | 2013 |
| 4. | Naba K. Mondal | J.C. Bose Fellowship, DST                                  | 2010 |

|    |                |  |      |
|----|----------------|--|------|
| 5. | Naba K. Mondal | Fellow, Indian Academy of Sciences, Bangalore      | 2010 |
| 6. | Naba K. Mondal | TWAS Fellowship                                    | 2010 |
| 7. | Naba K. Mondal | Fellow, Indian National Science Academy, New Delhi | 2008 |
| 8. | Naba K. Mondal | Fellow, National Academy of Sciences, Allahabad    | 2000 |

### International Awards

|    | Awardee        | Name of the Award/Honour                                 | Year |
|----|----------------|--|------|
| 1. | S. K. Gupta    | Vice-Chairman, Astroparticle Physics Commission (C4)     | 2013 |
| 2. | Naba K. Mondal | Member, Astroparticle Physics International Forum (APIF) | 2011 |
| 3. | Naba K. Mondal | TWAS Fellow  | 2010 |
| 4. | S. K. Gupta    | Associate Member, Cosmic Ray Commission (C4)             | 2010 |
| 5. | Naba K. Mondal | Member, International design study for neutrino factory  | 2007 |
| 6. | Naba K. Mondal | Esther Hoffman Beller Lecturership, APS                  | 2001 |

- **Students, Postdocs, Scientific Staff and Others:**

### National Awards

|  | Awardee              | Name of the Award/Honour   | Year |
|--|----------------------|--|------|
|  | Kolahal Bhattacharya | Prize for contributed paper, Colloquium for Young Physicists, IPS, Kolkata   | 2015 |
|  | B. Satyanarayana     | Senior Member of the IEEE and Executive Committee Member and Chair, Technical & Professional Activities of the IEEE Bombay Section | 2014 |
|  | B. Satyanarayana     | Fellow, Institution of Engineers (India), Kolkata  | 2009 |
|  | B. Satyanarayana     | Fellow, Institute of Electronics and Telecommunication Engineers, New Delhi  | 2009 |

**International Awards :** none

30. Seminars/ Conferences/Workshops organized and the source of funding (national / international) with details of outstanding participants, if any.

|    | Year              | Name  | Funding | Faculty members                       |
|----|-------------------|---|---------|---------------------------------------|
| 1. | Jan 10 – 12, 2011 | Workshop on Synergy between High Energy and High Luminosity Frontiers TIFR, Mumbai. | TIFR    | T. Aziz,<br>M. Guchait,<br>G. Mohanty |
| 2. | Oct 20 – 25, 2010 | 12th International Workshop on  | TIFR    | B.S. Acharya,                         |

|    | Year              | Name   | Funding                                 | Faculty members   |
|----|-------------------|--|---|---|
|    |                   | Neutrino factories, Super beams and Beta beams (NuFact10) TIFR, Mumbai.  |   | S. Banerjee,<br>G. Majumder<br>N.K. Mondal  |
| 3. | Aug 22 – 27, 2011 | XXV International Symposium on Lepton Photon Interactions at High Energies (Lepton Photon 2011), TIFR, Mumbai.                   | DAE, TIFR, IMSc, SINP, HRI, IUPAP, DESY | BS Acharya,<br>S. Banerjee,<br>M. Guchait,<br>N.K. Mondal,<br>G. Majumder,<br>K. Mazumdar |
| 4. | Mar 21 – 24, 2012 | National Symposium on Particles, Detectors and Instrumentation (NSPDI), TIFR, Mumbai.  | TIFR                                    | BS Acharya,<br>S. Banerjee,<br>G. Majumder,<br>N.K. Mondal                                |
| 5. | Jan 21 – 31, 2013 | Belle Analysis Workshop (BAW-2013), TIFR, Mumbai.  | TIFR                                    | T. Aziz,<br>G. Mohanty  |
| 6. | Nov 25-27, 2013   | National Symposium on VHE Gamma Ray Astronomy (NSGRA-2013) BARC Training School  | BARC, IIA, SINP, TIFR                   | B.S. Acharya,<br>V. R. Chitnis  |
| 7. | Jan 6 – 8, 2014   | International Conference on What Next at LHC (WNL2014), TIFR, Mumbai.  | TIFR                                    | S. Banerjee,<br>& others  |
| 8. | Nov 4 – 17, 2014  | The second Asia-Europe-Pacific School on High Energy Physics, Puri.  | CERN, KEK, Bose Inst., TIFR             | G. Majumder   |
| 9. | Mar 27 – 31, 2015 | National Symposium on Particles, Detectors, and Instrumentation – II Inter Institutional Centre for High Energy Physics, Madurai |   | B.S. Acharya,<br>S. Banerjee,<br>G. Majumder,<br>N.K. Mondal                              |

## 31. Code of ethics for research followed by the departments

[See Annexure B2-B for a detailed document which is applicable across TIFR Departments and Centres.](#)

## 32. Student profile programme-wise:

Numbers are summed over 2011 – 2015 batches.

| Programme<br>(c.f. q. no. 4) | Applications<br>received # | Selected |        | Joined |        | Pass<br>percentage* |            |
|------------------------------|----------------------------|----------|--------|--------|--------|---------------------|------------|
|                              |                            | Male     | Female | Male   | Female | Male                | Female     |
| Ph.D.                        | 21,370                     | 26       | 8      | 12     | 2      | 58                  | 100        |
| Int.M.Sc.-<br>Ph.D.          |                            | 11       | 1      | 4      | 1      | 100                 | 100        |
| <b>Total</b>                 |                            |          |        |        |        | <b>100</b>          | <b>100</b> |

# Applications include numbers for of all 5 Physics departments, viz. DAA, DCMP&MS, DHEP, DNAP and DTP.

## 33. Diversity of students

## (a) geographical

| Students                   | Ph.D.    |          | Int.-Ph.D. |          | Total     |
|----------------------------|----------|----------|------------|----------|-----------|
|                            | Male     | Female   | Male       | Female   |           |
| From the state where the   | 2        | 0        | 0          | 0        | 2         |
| From other states of India | 6        | 2        | 7          | 2        | 17        |
| NRI students               | —        | —        | —          | —        | —         |
| Foreign students           | —        | —        | —          | —        | —         |
| <b>Total</b>               | <b>8</b> | <b>2</b> | <b>7</b>   | <b>2</b> | <b>19</b> |

## (b) Undgraduate Institute

| Students from                       | Ph.D.    |          | Int.-Ph.D. |          | Total     |
|-------------------------------------|----------|----------|------------|----------|-----------|
|                                     | Male     | Female   | Male       | Female   |           |
| Indian Universities                 | 2        | 1        | 6          | 2        | 11        |
| Premier science institutions †      | 1        | 0        | 0          | 0        | 1         |
| Premier professional institutions # | 5        | 1        | 0          | 0        | 6         |
| Others*                             | 0        | 0        | 1          | 0        | 1         |
| Foreign Universities                | 0        | 0        | 0          | 0        | 0         |
| <b>Total</b>                        | <b>8</b> | <b>2</b> | <b>7</b>   | <b>2</b> | <b>19</b> |

34. How many students have cleared Civil Services and Defense Services examinations, NET, SET, GATE and other competitive examinations? Give details category-wise.

|    | Examination | No of students |
|----|-------------|----------------|
| 1. | NET         | 10             |
| 2. | GATE        | 7              |
| 3. | JEST        | 10             |
| 4. | Others      | 6              |

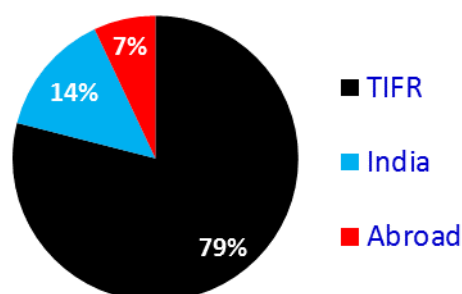
35. Student progression

- Ph.D. programme : Most of the students admitted to the DHEP go on to complete the course work and get their Ph.D.s. Once in a while (less than one per year), a student may opt out of the programme, for various reasons. Normally, after completing their Ph.D., students have to leave TIFR. The vast majority go elsewhere for postdoctoral research. A small number (< 10%) go for other employment, such as teaching positions or industry.
- Integrated M.Sc.-Ph.D. programme : Most of the students admitted to the DHEP go on to complete the course work and get their M.Sc.'s and Ph.D.s. Once in a while (less than one per year), a student may opt out of the programme, for various reasons. Normally, after completing their Ph.D., students have to leave TIFR. The vast majority go elsewhere for postdoctoral research. A small number (< 10%) go for other employment, such as teaching positions or industry

36. Diversity of staff

| Number of faculty who are Ph.D.'s  |           |
|------------------------------------|-----------|
| from TIFR :                        | 11        |
| from other institutions in India : | 2         |
| from institutions Abroad:          | 1         |
| <b>Total :</b>                     | <b>14</b> |

**Faculty Ph.D.s**



37. Number of faculty who were awarded M.Phil., Ph.D., D.Sc. and D.Litt. during the assessment period

The minimum eligibility criteria for selection as a member of the TIFR faculty is a Ph.D. degree. Thus, this question is not relevant.

38. Present details of departmental infrastructural facilities with regard to

- a) Library

DHEP, like other Departments of TIFR in the Colaba campus, makes use of the TIFR Library and Scientific Information Resource Centre (SIRC) (see Section B2, Item no 4.2)

- b) Internet facilities for staff and students

DHEP, like other Departments of TIFR in the Colaba campus, makes use of the TIFR Computer Centre and Communication Facility (see Section B2, Item no 4.3)

- c) Total number of class rooms

DHEP, like other Departments of TIFR in the Colaba campus, makes use of the common class rooms and lecture theatres of TIFR (see Section B1, Item no 12)

- d) Class rooms with ICT facility

All the classrooms above have ICT facilities like overhead projectors, Wi-Fi, etc. Video-conferencing possibilities are also available in most of the lecture rooms.

- e) Students' laboratories

- For the compulsory Experimental Physics courses and for all the Projects, students have access to the well-equipped laboratories of DHEP (see Item f) below)
- In addition students of both Ph.D. and Integrated-Ph.D. have one Teaching Laboratory which has specific experimental setups which are used during the coursework period.

## f) Research laboratories

|    | <b>Name of Laboratory</b>                             | <b>Fac*</b> | <b>PDF<sup>†</sup></b> | <b>Stu<sup>‡</sup></b> | <b>Brief description of research activity</b>   |
|----|---|-------------|------------------------|------------------------|---|
| 1. | High Altitude Gamma-ray Observatory at Hanle (Ladakh) | 2           | 2                      | 2                      | Ground-based very high energy gamma ray astronomy   |
| 2. | Silicon Detector Laboratory                           | 1           | 2                      | 7                      | a) In-house detector R&D involving single-& double-sided silicon microstrip sensors,<br>b) Participation in the design, prototyping and construction of Belle-II silicon vertex detector and phase-II CMS tracker   |
| 3. | Fundamental Interactions and Gravitation              | 1           | 1                      | 3                      | Experiments to study and test fundamental aspects of gravity, deviations from standard theories and applications in high precision Metro-logy. Study of gravitational waves and study of light-matter interactions. |
| 4. | INO R & D Facility (Madurai)                          | 5           | 1                      | 10                     | To design and develop RPC detectors and associated electronics for the INO facility.  |
| 5. | Cosmic Ray Laboratory (Ooty)                          | 1           | 1                      | 1                      | Study of cosmic rays  |
| 6. | Gauribidanur laboratory                               | 1           | 0                      | 0                      | Test of the equivalence principle   |
| 7. | Cosmic Ray Lab  | 3           | 1                      | 20                     | Cosmic Ray Muon detection setup. Regularly used for TIFR graduate course  |
| 8. | Grid Computing lab                                    | 2           |                        |                        | Serves international CMS collaboration including about 100 Indians for Grid Computing in CMS experiment at LHC.   |

\* no of faculty members using the laboratory

† no of postdoctoral fellows using the laboratory

‡ no of graduate students using the laboratory

DHEP members are also involved in the setting up and running of the following major international facilities:

|    | <b>Name of Laboratory</b> | <b>Fac*</b> | <b>PDF<sup>†</sup></b> | <b>Stu<sup>‡</sup></b> | <b>Brief description of research activity</b> |
|----|---------------------------|-------------|------------------------|------------------------|---|
| 1. | Fermilab (USA)            | 2           | 0                      | 0                      | Search for elementary particles               |
| 2. | CERN (Switzerland)        | 7           | 1                      | 10                     | Search for elementary particles               |
| 3. | KEK (Japan)               | 2           | 0                      | 2                      | Study of bottom quark properties              |

\* no of faculty members using the laboratory

† no of postdoctoral fellows using the laboratory

‡ no of graduate students using the laboratory

### 39. List of doctoral, post-doctoral students and Research Associates

| Doctoral students |                          | Post-doctoral fellows |                          |
|-------------------|--------------------------|-----------------------|--------------------------|
| 1.                | Gauranga Kole            | 1.                    | Arun K Baby              |
| 2.                | Rajdeep Mohan Chatterjee | 2.                    | Susnata Seth             |
| 3.                | Ram Krishna Deewanjee    | 3.                    | Deepanwita Dutta         |
| 4.                | Atreyee Sinha            | 4.                    | Vipin Gaur               |
| 5.                | Nairit Sur               | 5.                    | Sandhya Jain             |
| 6.                | Soureek Mitra            |                       |                          |
| 7.                | Bibhuprasad Mahakud      | <b>JRFs</b>           |                          |
| 8.                | Jacky Kumar              | 1.                    | Akshay Manjare           |
| 9.                | Varghese Babu            | 2.                    | B.S. Mallikarjuna        |
| 10.               | Bajrang Janu Sutar       | 3.                    | Akhil M. Kurup           |
| 11.               | Ninad Jetty              | 4.                    | Sarrah Shabbir Lokanwala |
| 12.               | V. Jhansi Bhavani        | 5.                    | J. Serin Varghese        |
| 13.               | Meenakshi Gaira          | 6.                    | Anuj Chandra             |
| 14.               | Aravind H. Vijay         |                       |                          |
| 15.               | Pallabi Das              |                       |                          |
| 16.               | Arkadipta Sarkar         |                       |                          |
| 17.               | Soham Bhattacharya       |                       |                          |
| 18.               | Suman Chatterjee         |                       |                          |
| 19.               | Uttiya Sarkar            |                       |                          |
| 20.               | Rajat Kumar Mandal       |                       |                          |

### 40. Number of post graduate students getting financial assistance from the university.

ALL the students of DHEP (13) are in doctoral programmes, and hence they are all given TIFR fellowships.

### 41. Was any need assessment exercise undertaken before the development of new programme(s)? If so, highlight the methodology.

DHEP, and TIFR as a whole, has been training students for Ph.D. since its inception in 1945. During the 1990's, a need was felt for a special programme to allow exceptionally bright students an early entry into research, i.e. directly



after their B.Sc.'s. This was felt on the basis of the Institute's well-established VSRP programme (see Item 48 below), where it was seen that many of the best students were already prepared for graduate school, even though they were only half-way through their M.Sc. programmes. It was therefore, decided to admit some exceptionally bright B.Sc. students directly to the Ph.D. programme, teach them the basic M.Sc. courses in a period of one year, and then permit them to do advanced electives and project work similar to M.Sc.'s. Based on the success of this move, the Integrated M.Sc.-Ph.D. programme, was formally started in 2012.

42. Does the department obtain feedback from

- a. faculty on curriculum as well as teaching-learning-evaluation? If yes, how does the department utilize the feedback?

The Subject Board of Physics includes a Course Coordinator, who is constantly in touch with the Instructors of different courses, and collects their feedback at regular intervals. This is used to (a) advise the Instructors, (b) update the Syllabus, and (c) fine-tune the curriculum.

In 2012, an exercise was carried out, in which feedback was requested from all the Instructors of the previous 5 years. Based on their suggestions, the course curriculum was thoroughly revised and rejuvenated.

- b. students on staff, curriculum and teaching-learning-evaluation and how does the department utilize the feedback?

The Course Coordinator (see above) also collects anonymous feedback on every course from the students in a form specifically designed for this purpose. The relevant portions in this are communicated to the Instructors, for modification and rectification in their pedagogic styles. These feedback forms also form an important input in selecting a faculty for the Excellence in Teaching Award of the TIFR Alumni Association.

- c. alumni and employers on the programmes offered and how does the department utilize the feedback?

Currently no such feedback is collected on a formal basis.

## 43. List the distinguished alumni of the department (maximum 10)

|     | Alumnus            | Reason for Distinction   |
|-----|--------------------|--|
| 1.  | M.G.K. Menon       | Padma Vibhushan, FRS, Ex-Director, TIFR, Ex-Director, TIFR, Ex-Chairman, ISRO, Scientific Advisor to PM, Ex-Union Minister of Science & Technology, Founder member, TWAS, Ex-President of all 3 Academies of Science |
| 2.  | B.V. Sreekantan    | Padma Bhushan, Ex-Director of TIFR, C.V. Raman award, INSA Srinivasa Ramanujan chair, Fellow of all 3 Academies of Science   |
| 3.  | Yash Pal           | Padma Vibhushan, Marconi Award, Lal Bahadur Shastri Award, Ex-Director, SAC, Ex-Chairman, UGC, Ex-Secretary, DST   |
| 4.  | Devendra Lal       | Padma Shri, FRS, Bhatnagar Award, Krishnan Medal, Goldschmidt Medal, Ex-Director, PRL  |
| 5.  | P.V. Ramanamurthy  | Pioneer of Cosmic Ray experiments in India, Founder, Cosmic ray laboratory at Udhagamandalam, Co-discoverer of atmospheric neutrinos   |
| 6.  | Prince K. Malhotra | Pioneered study of elementary particles at accelerator based experiments at TIFR in the '70. Discovery of Malhotra-Wroblewski regularity, Member of IUPAP, ICFA, INSA Fellow.  |
| 7.  | V.S. Narasimham    | Pioneer, KGF neutrino experiments (discovery: atmospheric neutrinos). Led TIFR group in the D0 experiment (discovery of top quark).  |
| 8.  | S. Tonwar          | Pioneer, GRAPES-II facility at Udhagamandalam. Chair, International Cosmic Ray Commission (2008-2011).   |
| 9.  | Atul Gurtu         | Spokesperson, India-CMS collaboration till 2011, INSA Fellow. Distinguished Professor at the King Abdulaziz University, Saudi Arabia.  |
| 10. | Sunanda Banerjee   | INSA Fellow. One of the main architects for the offline software for the L3 and CMS experiments.   |

## 44. Give details of student enrichment programmes (special lectures / workshops / seminar) involving external experts.

As Item No 30 shows, the DHEP regularly conducts conferences etc. which are attended by all the doctoral students, and these provide the required introduction to the state of the art in the subjects of their research. In addition, TIFR has a vibrant programme of seminars, colloquia and public lectures which the students are encouraged to attend and absorb as much information as they can.

45. List the teaching methods adopted by the faculty for different programmes.

The DHEP generally adopts the conventional blackboard teaching methods. Often slides are shown to illustrate experimental or numerical facts. For project work, students are required to work hands-on in a laboratory.

46. How does the department ensure that programme objectives are constantly met and learning outcomes are monitored?

The DHEP Chairperson and another member of the DHEP faculty are members of the Subject Board of Physics, which constantly monitors the progress of the students and obtains feedback from faculty and students alike.

47. Highlight the participation of students and faculty in extension activities.

DHEP faculty, postdocs and students regularly participate in the Outreach Activities of TIFR (see Appendix ?)

48. Give details of “beyond syllabus scholarly activities” of the department.

The DHEP conducts and participates in the following activities on a regular basis.

- DHEP Seminar
- NSF Colloquium
- VSRP Programme

49. State whether the programme/ department is accredited/ graded by other agencies? If yes, give details.

The Academic performance of DHEP was reviewed by a panel of international experts in 2008, set up by the Governing Council of TIFR. In addition, a Review Committee constituted by the UGC, visited TIFR during February 2010, and commented that the deemed to be university status of TIFR offers a unique multidisciplinary environment for carrying out research. The present composition of the faculty members and research facilities at DCS are equally well placed to meet the above description.

50. Briefly highlight the contributions of the department in generating new knowledge, basic or applied.
1. Discovery of the atmospheric neutrinos, Top Quark and the Higgs boson are the major achievements in the field of particle physics in which members of the department have participated.
  2. Several new bound states of the bottom quark have been found in searches conducted by the members of the department.
  3. For the first time in India members of the department created Bose-Einstein condensates by cooling Rubidium atoms to a temperature close to that of absolute zero.
  4. Several detectors, e.g. the Proportional Wire Chambers made by members of the department for the KGF experiments are still working and are being used by the GRAPES experiment at Udhagamalam.
  5. Several electronic modules, TDCs, CAMAC controllers, NIM to ECL convertors, programmable discriminators, delay generators have been made by members of the department and some of this knowhow has been transferred to the industry.
  6. Resistive Plate Chambers were manufactured in-house in the department and then the knowledge was transferred to industry for mass production.
51. Detail five major Strengths, Weaknesses, Opportunities and Challenges (SWOC) of the department.

**Strengths**

- Participation in cutting edge research with large collaborative efforts.
- Opportunity to develop electronics, detector hardware of various types in house. This experience can be used in other areas of science including medical science.
- Interaction with the industry while building the hardware and valuable knowledge transfer.
- Due to several foreign collaborations, knowledge about software and

hardware is exchanged worldwide by the members of the department.

- Opportunity to train human personnel in India as well as in several laboratories abroad (Fermilab, KEK, CERN).

### **Weaknesses**

- Not enough human resource available
- Since members of the department are part of big collaborations, there are ample opportunity to take responsibilities for building parts of the detectors for these experiments and also the related electronics. But all these jobs need adequate support in terms of skilled scientific and technical officers as well as engineers.
- It is extremely difficult to employ new people with such skills in the current system. We can hire new people only if somebody retires. We can employ people on project posts but they are temporary and it is hard to find good people for them.
- Not enough students available to work on experimental topics. With the TIFR system of inducting new students we get very few who want to join the experimental streams. Same is true for postdoctoral fellows.
- Due to the foreign collaborations it is sometimes necessary to visit the laboratories abroad for a few months in a year. It is difficult to manage these foreign visits for faculty members.
- Special parts are often needed while building equipment (detector elements as well as electronics). Several companies have embargo on electronic items as well as some material. This makes the task of hardware building very difficult. Indian industry often does not produce the right kind of items with enough precision which can replace the imported parts.

### **Opportunities**

- For training human resource
- Opportunity to develop electronics, detector hardware of various types in

house.

- Opportunity to learn to deal with large volumes of data and the related software.
- Interaction with the industry while building the hardware and training opportunities.
- Opportunity to train human personnel in India as well as in several laboratories abroad (Fermilab, KEK, CERN).
- Opportunity to work with large number of people in big collaborations.

### **Challenges**

- Deal with large number of collaborators.
- Keep international deadlines.
- Organize the administrative side of the collaborations.
- Keep track of the purchase orders, deliveries, quality control of items bought and manufactured.
- Damage control in case of hardware or software failure in any system.

### 52. Future plans of the department

Continue participation in cutting edge research, in accelerator based programmes at LHC in CERN, and at Belle in KEK. Searches for new particles and phenomena at the energy and intensity frontiers as well as exploring matter-antimatter asymmetry and new physics phenomena at the luminosity frontier. The field of accelerator based high energy physics is poised for an interesting phase with the recent discovery of Higgs boson in 2012 during the Run I of LHC and the prospect of discovery of new physics at Run II of LHC in near future and also during later operations of LHC with much higher luminosity. After the discovery of the elusive Higgs, the natural course will be to study its properties with precision. Since the most successful theory to solve the anomalies associated with standard model is the theory of supersymmetry, a search for the supersymmetric Higgs will be an important goal for the future LHC programmes. Further, the vindication of electroweak symmetry breaking with Higgs boson at the heart of it can only be done by studying longitudinal vector boson scattering at high luminosity. This

requires significant upgrade of the LHC experiments. A comprehensive design of CMS upgrade has been approved and TIFR members are engaged in R&D efforts. The pace of such activities will intensify in next few years leading to building prototype detectors, study at the test-beams followed by production of subsystems including electronics. CMS members in DHEP are planning various activities that will be pursued in the future, e.g., Fabrication of electronics for Phase I upgrade of the hadron calorimeter.

Department Intends to do the following immediately : R&D for phase II upgrade of hadron calorimeter, tracker, trigger subsystem. Participation in phase II detector construction in specific subsystems. Collision data collection, monitoring the detector, analyses including detector calibration during the next 2 decades of LHC operation. Physics performance studies of the upgraded detector in the high-luminosity LHC era. Various managerial responsibilities in the CMS collaboration.

Get into emerging areas of research like Gravity wave detection with the LIGO-India project : One direction is innovative contributions to gravitational wave astronomy involving low frequency detectors and cold atom interferometers. This will also lead to navigational quality devices sensitive to gravity and inertial fields. Another direction, which is already progressing, with results of verifiable empirical strength is the tests of gravitational effects of cosmic matter in classical and quantum dynamics. Both are well planned programs that will be continuing and develop to completion over the next 8 years or so. This time scale matches well with the LIGO-India project commissioning as well. The developments in gravitational wave research have a long term scope of around 20 years and could be followed up by others later, here or elsewhere.

Build and operate India-based Neutrino Observatory (INO) for the study of properties of neutrinos, the elusive particles which are also the building blocks of matter. RPCs are fast, planar, rugged and low-cost gas detectors which are being, and will be, used extensively in a number of high energy and astro-particle physics experiments. The INO group members at TIFR have developed enough expertise in the construction of single gap glass RPCs. These chambers are performing excellently thus proving themselves to be a perfect choice as active detector elements for the ICAL experiment. They also find applications for charged particle detection, time of flight, tracking and digital calorimetry due to their large signal

amplitudes as well as excellent position and time resolutions.

Time resolution of large area single gap RPC in the existing experiments is about 1.5 to 3ns. Resolutions of the order of 50ps were obtained with multi-gap RPCs, but based on cost considerations they may not be suitable for deployment in large scale experiments. The INO group has obtained sub-ns time resolution in single-gap RPCs and are in the process of improving further, which can then be used for future cosmic ray experiments to improve the directionality of the initial cosmic ray particles as well as neutrinos like in the case of INO-ICAL.

Other areas of detector R&D which will be of significant importance in the current Indian context are noble liquid (especially liquid Argon and Xenon) detecting medium based calorimeter/time projection chambers. Highly interesting work which involves reading out these chambers using modern thin gas gap detectors will also be pursued. These configurations lead to unprecedented position and time resolutions, making them highly suitable for future experiments that can be setup in the INO underground laboratory like Dark matter Search experiment, Proton decay, atmospheric electron neutrino experiment etc. They will also have application in the area of medical imaging.

Another area of our expertise, which will be beneficial to develop, is concerning front-end electronics and high resolution timing measurement, which are inevitably crucial components for future detector readout needs including the above mentioned detectors. Besides, high contrast digital radiography and imaging also needs advances in readout electronics, particularly in the front-end. By coupling and integrating the front-end electronics with detectors, one can improve the signal-to-noise enormously. With the experience that has already been gained over many decades on electronics and readout systems, members propose a dedicated research programme to develop high gain, low noise front-end ASICs as well as FPGA/ASIC based high resolution Time-to-Digital Converter (TDC) chips.

Observe the Universe in the gamma ray window using the MACE telescope at Hanle in Ladakh. Future of the field of ground based gamma ray astronomy lies with the Cherenkov Telescope Array (CTA). This is the next generation experiment with an order of magnitude improvement in various parameters including sensitivity, angular and energy resolution as compared to the present generation big telescopes. For CTA, two arrays of telescopes of assorted sizes are envisaged,



one in the Northern and one in the Southern hemisphere. This will give complete sky coverage over a wide band of energy from few 10's of GeV to beyond 100 TeV. This is going to be an enormous effort and at present CTA has participation from more than 1200 scientists/engineers from 31 countries. Presently our group is participating in the R&D effort towards two work-packages of the CTA: developing a calibration device for the prototype LST (Large Size Telescope) in collaboration with SINP and development of software for Array Control and Data Acquisition (ACTL work-package). Members of DHEP have joined the collaboration along with BARC, SINP and IIA with no commitment of funds during design stage of the project. Now the project has moved from R&D stage to fabrication of prototype. We would like to be associated with the CTA project during the construction of the observatory with financial commitments. This is the direction in which we aim to proceed in future.

Study of quantum mechanics and quantum optics of degenerate bosons and fermions using laser cooled ultra-cold atoms.

GRAPES-III experiment will continue the study of cosmic rays with an upgraded detector with an increased muon coverage by 20%.

Strengthen the detector R & D activities of the department by engaging in collaborative efforts with advanced laboratories like Fermilab, CERN, ANL, KEK for state of the art detectors and readout systems.

Continue the Electronics R & D efforts for detector instrumentation. Collaborate with national and international groups involved with similar research.